

METHOD #: 180.1 Approved for NPDES (Editorial Revision 1974, 1978)

TITLE: Turbidity (Nephelometric)

ANALYTE: Turbidity

INSTRUMENTATION: Turbidimeter

STORET No. 00076

1.0 Scope and Application

- 1.1 This method is applicable to drinking, surface, and saline waters in the range of turbidity from 0 to 40 nephelometric turbidity units (NTU). Higher values may be obtained with dilution of the sample.
- NOTE 1:** NTU's are considered comparable to the previously reported Formazin Turbidity Units (FTU) and Jackson Turbidity Units (JTU).

2.0 Summary of Method

- 2.1 The method is based upon a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension. The higher the intensity of scattered light, the higher the turbidity. Readings, in NTU's, are made in a nephelometer designed according to specifications outlined in Apparatus. A standard suspension of Formazin, prepared under closely defined conditions, is used to calibrate the instrument.
- 2.1.1 Formazin polymer is used as the turbidity reference suspension for water because it is more reproducible than other types of standards previously used for turbidity standards.
- 2.1.2 A commercially available polymer standard is also approved for use for the National Interim Primary Drinking Water Regulations. This standard is identified as AMCO-AEPA-1 available from Amco Standard International, Inc.

3.0 Sample Handling and Preservation

- 3.1 Preservation of the sample is not practical; analysis should begin as soon as possible. Refrigeration or icing to 4°C, to minimize microbiological decomposition of solids, is recommended.

4.0 Interferences

- 4.1 The presence of floating debris and coarse sediments which settle out rapidly will give low readings. Finely divided air bubbles will affect the results in a positive manner.
- 4.2 The presence of true color, that is the color of water which is due to dissolved substances which absorb light, will cause turbidities to be low, although this effect is generally not significant with finished waters.

5.0 Apparatus

- 5.1 The turbidimeter shall consist of a nephelometer with light source for illuminating the sample and one or more photo-electric detectors with a readout device to indicate the intensity of light scattered at right angles to the path of the incident light. The turbidimeter should be so designed that little stray light reaches the detector in the absence of turbidity and should be free from significant drift after a short warm-up period.
- 5.2 The sensitivity of the instrument should permit detection of a turbidity difference of 0.02 unit or less in waters having turbidities less than 1 unit. The instrument should measure from 0 to 40 units turbidity. Several ranges will be necessary to obtain both adequate coverage and sufficient sensitivity for low turbidities.
- 5.3 The sample tubes to be used with the available instrument must be of clear, colorless glass. They should be kept scrupulously clean, both inside and out, and discarded when they become scratched or etched. They must not be handled at all where the light strikes them, but should be provided with sufficient extra length, or with a protective case, so that they may be handled.
- 5.4 Differences in physical design of turbidimeters will cause differences in measured values for turbidity even though the same suspension is used for calibration. To minimize such differences, the following design criteria should be observed:
 - 5.4.1 Light source: Tungsten lamp operated at a color temperature between 2200-3000 °K.
 - 5.4.2 Distance traversed by incident light and scattered light within the sample tube: Total not to exceed 10 cm.
 - 5.4.3 Detector: Centered at 90° to the incident light path and not to exceed $\pm 30^\circ$ from 90°C. The Detector, and filter system if used, shall have a spectral peak response between 400 and 600 nm.
- 5.5 The Hach Turbidimeter, Model 2100 and 2100 A, is in wide use and has been found to be reliable; however, other instruments meeting the above design criteria are acceptable.

6.0 Reagents

- 6.1 Turbidity-free water: Pass distilled water through a 0.45 μ pore size membrane filter if such filtered water shows a lower turbidity than the distilled water.
- 6.2 Stock formazin turbidity suspension: Solution 1: Dissolve 1.00 g hydrazine sulfate, $(\text{NH}_2)_2 \cdot \text{H}_2\text{SO}_4$, in distilled water and dilute to 100 mL in a volumetric flask. Solution 2: Dissolve 10.00 g hexamethylene-tetramine in distilled water and dilute to 100 mL in a volumetric flask. In a 100 mL volumetric flask, mix 5.0 mL Solution 1 with 5.0 mL Solution 2. Allow to stand 24 hours at $25 \pm 3^\circ\text{C}$, then dilute to the mark and mix.
- 6.3 Standard formazin turbidity suspension: Dilute 10.00 mL stock turbidity suspension to 100 mL with turbidity-free water. The turbidity of this suspension is defined as 40 units. Dilute portions of the standard turbidity suspension with turbidity-free water as required.
 - 6.3.1 A new stock turbidity suspension should be prepared each month. The standard turbidity suspension and dilute turbidity standards

should be prepared weekly by dilution of the stock turbidity suspension.

- 6.4 The AMCO-AEPA-1 standard as supplied requires no preparation or dilution prior to use.

7.0 Procedure

- 7.1 Turbidimeter calibration: The manufacturer's operating instructions should be followed. Measure standards on the turbidimeter covering the range of interest. If the instrument is already calibrated in standard turbidity units, this procedure will check the accuracy of the calibration scales. At least one standard should be run in each instrument range to be used. Some instruments permit adjustments of sensitivity so that scale values will correspond to turbidities. Reliance on a manufacturer's solid scattering standard for setting overall instrument sensitivity for all ranges is not an acceptable practice unless the turbidimeter has been shown to be free of drift on all ranges. If a pre-calibrated scale is not supplied, then calibration curves should be prepared for each range of the instrument.

- 7.2 Turbidities less than 40 units: Shake the sample to thoroughly sample into the turbidimeter tube. Read the turbidity directly from the instrument scale or from the appropriate calibration curve.

- 7.3 Turbidities exceeding 40 units: Dilute the sample with one or more volumes of turbidity-free water until the turbidity falls below 40 units. The turbidity of the original sample is then computed from the turbidity of the diluted sample and the dilution factor. For example, if 5 volumes of turbidity-free water were added to 1 volume of sample, and the diluted sample showed a turbidity of 30 units, then the turbidity of the original sample was 180 units.

- 7.3.1 The Hach Turbidimeters, Models 2100 and 2100A, are equipped with 5 separate scales: 0-0.2, 0-1.0, 0-100, and 0-1000 NTU. The upper scales are to be used only as indicators of required dilution volumes to reduce readings to less than 40 NTU.

NOTE 2: Comparative work performed in the MDQAR Laboratory indicates a progressive error on sample turbidities in excess of 40 units.

8.0 Calculation

- 8.1 Multiply sample readings by appropriate dilution to obtain final reading.
8.2 Report results as follows:

NTU	Record to Nearest:
0.0 - 1.0	0.05
1 - 10	0.1
10 - 40	1
40 - 100	5
100 - 400	10
400 - 1000	50
> 1000	100

9.0 Precision and Accuracy

- 9.1 In a single laboratory (EMSL), using surface water samples at levels of 26, 41, 75 and 180 NTU, the standard deviations were ± 0.60 , ± 0.94 , ± 1.2 and ± 4.7 units, respectively.
- 9.2 Accuracy data are not available at this time.

Bibliography

1. Annual Book of ASTM Standards, Part 31, "Water", Standard D1889-71, p 223 (1976).
2. Standard Methods for the Examination of Water and Wastewater, 14th Edition, p 132, Method 214A, (1975).